The Oil Valley Hornist

Experimentation and exploration of microtonal, just-intonation, and Xenharmonic music for the French Horn.

Microtonality and the Horn

Posted by Allan Mathieu Perkins on October 22, 2011

Most of the music composed in the western tradition is based on a system known as 12-tone equal temperament, which divides the octave into 12 equal divisions with each interval commonly referred to as a semitone or a half-step. Music which uses intervals smaller than the semitone is referred to as microtonal music; however the term microtonal is also often used to refer to any tuning system different from standard twelve-tone equal temperament. The music of certain cultures, such as India and the Middle East, which developed tuning systems other than equal-temperament commonly use intervals which are considered to be microtonal.

(http://theoilvalleyhornist.files.wordpress.com/2012/11/archicembalo-reproduction.jpg)
A reproduction of Nicola Vincentio's 31-tone Archicembalo

The practice of using microtones dates back to at least the music of Ancient Greece, which used an enharmonic tetrachord (series of four notes) with intervals as small as a third of a semitone as described by the philosopher Archytas (428 – 347 B.C.). Two early examples of microtones in western music date to the mid-16th century: in 1555, Nicola Vincentio designed a harpsichord-like instrument known as an archicembalo which was capable of playing music based on a 31 equal division of the octave tuning system and in 1558, Guillaume Costeley wrote his chanson *Seigneur Dieu ta pitié* which uses a 19 equal division of the octave tuning system. After the acceptance of 12-tone equal temperament as standard practice, microtonality received little attention until the early 20th century with the only notable exception to this is Jacques Fromental Halévy's quarter-tone composition *Prométhée enchaîné* written in 1849.


(http://theoilvalleyhornist.files.wordpress.com/2011/10/ivan-wyschnegradsky-with-quarter-tone-piano.jpg)
Ivan Wyschnegradsky with Quarter Tone Piano

Advances in technology aided the development of microtonal music in the 20th century. Inventions such as the phonograph allowed music from Eastern cultures, which used systems other than 12-tone, to be recorded and become accessible to Western musicians at the time when many composers were looking to reach beyond the limitations of the 12-tone system. In the early 20th century (1910s-20s), composers such as Charles Ives, Alios Hába, Ivan Wyschnegradsky and several others began to experiment with quarter-tones, eighth-tones, and irregular divisions of the octave.

Several composers began to construct new instruments or altered existing instruments to be capable of performing on these new tonalities. One of the most significant instrument maker/composers was Harry Partch, who built an entire orchestra of just intonation and other tuned instruments capable of playing his compositions. Further advances in technology, including electronic instruments and snythesizers, opened many new possibilities for microtonal music. Karlheinz Stockhausen was the

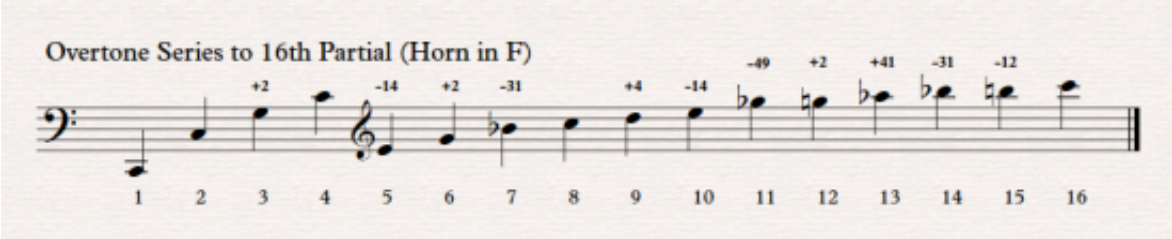
first to publish a piece for electronic media with his *Elektronische Studien* in 1954. Since then, many composers have taken advantage of electronic instruments to create music of a subtlety and complexity virtually impossible without the aid of a machine.

The Horn's Microtonal Capabilities:

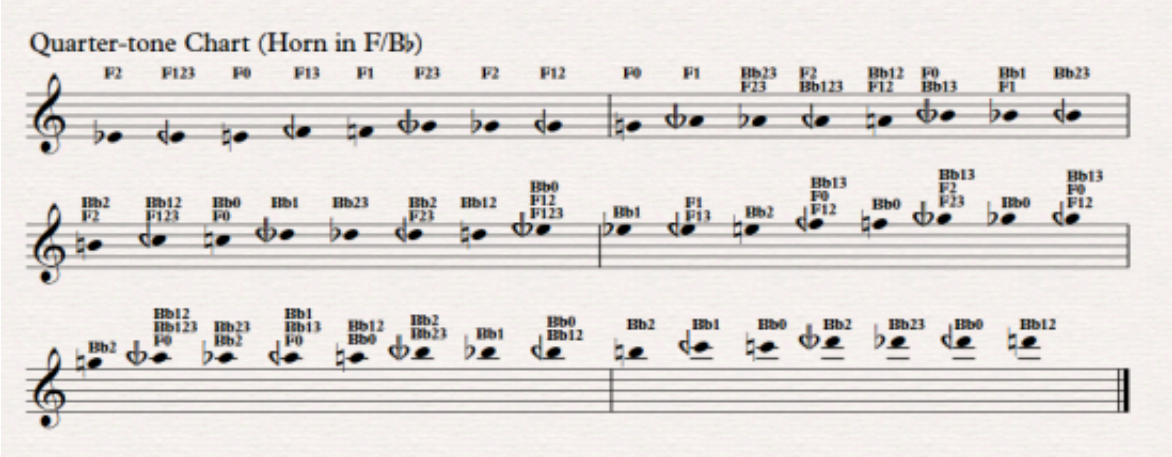
There are several techniques available to the horn which allow it to play microtonally. There are naturally occurring microtones found within the horn's overtone series, and there are also numerous alternate fingerings, alternate tuning systems, embouchure and right hand techniques which can alter the pitch as well as several other physical effects capable of creating microtonal inflections.

Microtonality from the Horn's Overtone Series:

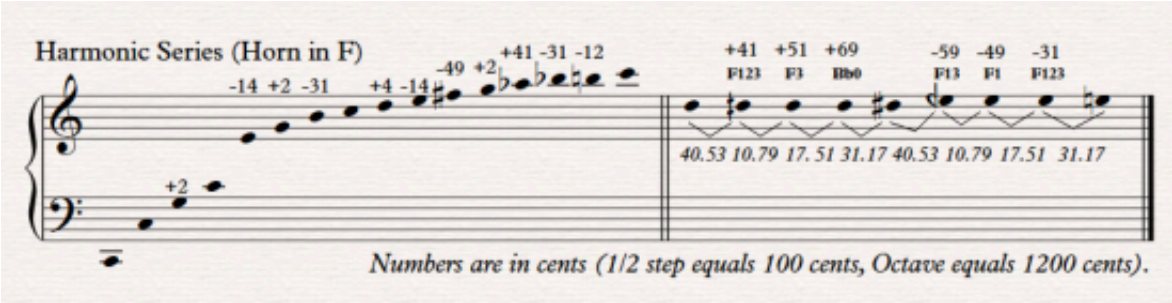
Without the aid of valves or various right-hand techniques, the horn, like other brasses, is only capable of playing notes from the harmonic series. The horn, however, has the advantage of a tremendous range which is easily accessible to even an amateur hornist. While the trumpet is largely limited to a range of around 2 1/2 to 3 octaves for all but the most skilled performers, most professional players of the horn can safely be assumed to have a 4 octave range, with some players capable of 4 1/2 to 5 octaves. This means that the horn can easily access a larger number of partials from the overtone series, even up to the 24th partial (written G6).



(http://theoilvalleyhornist.files.wordpress.com/2012/11/microtonality-and-the-horn-example-no-8-overtone-series.png)Certain partials of the harmonic series, namely the 7th, 11th, and 13th, do not match the 12-tone equal temperament system well, and have long been avoided as out of tune 'wolf tones.' However, many composers and hornists have devised different ways to take advantage of these partials in modern music, particularly those compositions which fall outside the standard 12-tone system.

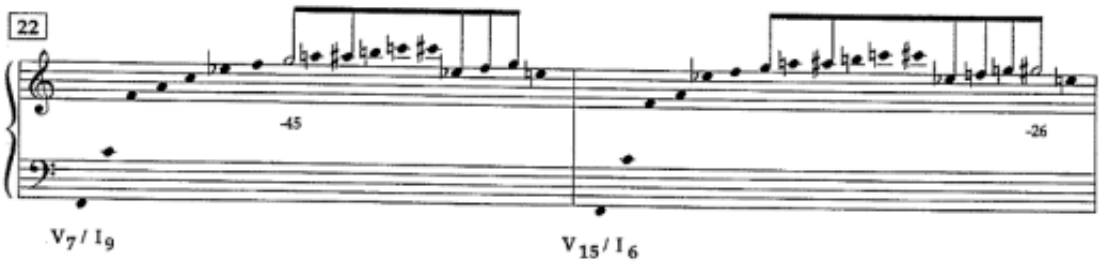


(http://theoilvalleyhornist.files.wordpress.com/2012/11/microtonality-and-the-horn-example-no-4-quartertone-fingering-chart-from-overtone-series.png)By taking advantage of the notes of the 7th, 11th, and 13th partials, a naturally occurring quartertone scale is possible in the upper half of the horn's range. While the notes of the 11th partial are nearly an exact quartertone flat (-49 cents), the 7th partial (-31 cents) and the 13th partial (-59 cents) are not quite as accurate. In most of the compositions for horn which take advantage of this property, these partials are not used as quartertones but as a specific non-tempered pitch, György Ligeti's *Hamburgisches Konzert* (Hamburg Concerto) is a prime example of this treatment.

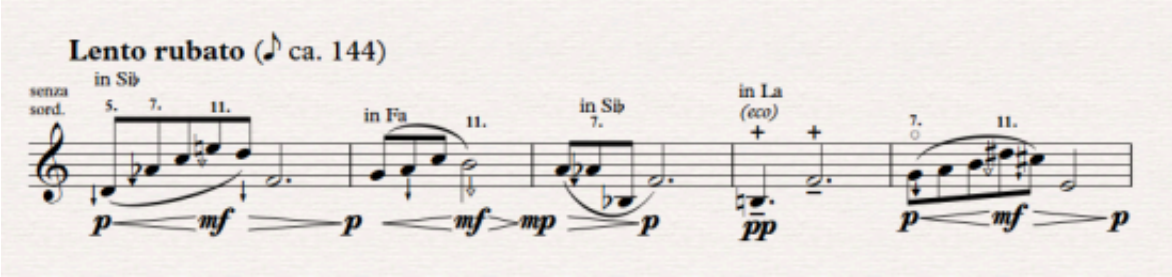


(http://theoilvalleyhornist.files.wordpress.com/2012/12/horn-harmonic-series-and-microtone-example.png)This concept was taken a step further by Dr. Spiros Mazis, whose research into the microtonal capabilities of brass instruments showed that the horn is capable of great subtleties of pitch. By using alternate fingerings and different partials, the horn is able to play eight or more uniquely identifiable pitches within the distance of a whole step, with some intervals being as small as a 1/10 step. The possibilities of this technique increase as one plays higher in the range where the partials are closer together.

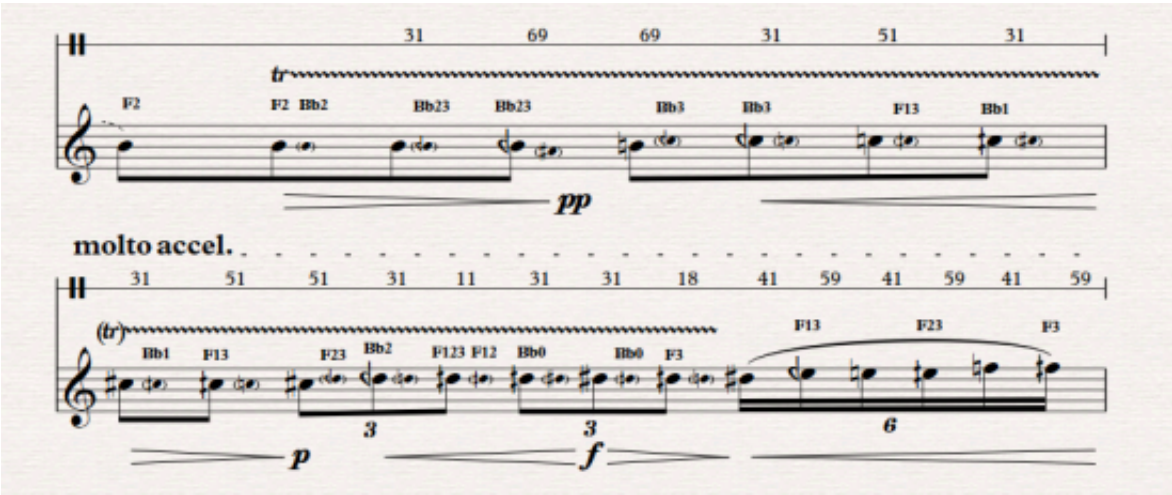
Examples from the Repertoire:



(http://theoilvalleyhornist.files.wordpress.com/2012/11/microtonality-and-the-horn-example-no-2-polansky-horn.png)Polansky, Larry: *Horn*, Page 2: This piece for horn and tape/live electronics is centered around three separate harmonic series, in F, A, and C, which shift from one to the next. Each measure of the piece contains an arpeggio from a specific harmonic series, the notes of which may be played in any order for an indeterminate length of time. *Horn*, which is based on an earlier piece by Polansky entitled *Psaltery*, explores the harmonic series of the horn in a highly aleatoric and improvisatory way, including the naturally occuring microtonal partials indicated by a measurement in cents beneath the note (-45 & -26 in the example above).



(http://theoilvalleyhornist.files.wordpress.com/2012/11/microtonality-and-the-horn-example-no-1-ligeti-hamburg-concerto.png)Ligeti, György: *Hamburgisches Konzert* (Hamburg Concerto), Mvmt. IV: Solo: Ligeti's Hamburg Concerto for horn and chamber orchestra with two basset horns and four obbligato natural horns is an excellent example of the horn's natural harmonic capabilities. For this piece, Ligeti instructs the four natural horn players to not 'correct' the non-tempered pitches with the right hand and allow the natural partials to sound unaltered. This passage is from the beginning of the fourth movement where the solo horn plays unaccompanied. The unusual arrow notation is due to the fact that there no specific symbols for 14, 31, and 49 cent intervals, which correspond to the 5th, 7th, and 11th partials of the horn respectively. In addition to the arrows, the numbers written above certain notes indicate the specific partial to which that note belongs.

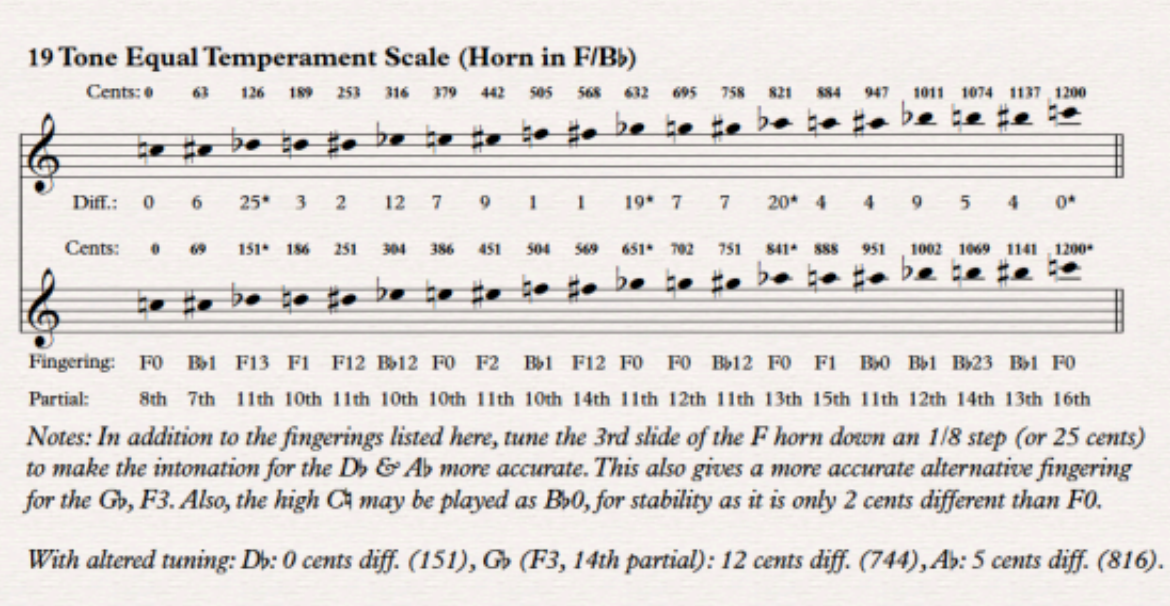


(http://theoilvalleyhornist.files.wordpress.com/2012/12/ialemos-example-4-v3.png)Mazis, Spiros: Ialemos (for Solo Horn), Op. 79: This piece incorporates Dr. Mazis' research on the microtonal capabilities of the horn and contains many passages which call for very subtle micro-intervalic motion. Primarily based on the ancient Greek enharmonic tetrachord, *Ialemos* also explores the horn's naturally occurring harmonic series. This passage shows some of the unique notations found in the piece, namely a two-staff system and numbers which mark the distance in cents between micro-intervals. The quartertone accidentals in this piece do not refer to a specific interval but rather a direction of pitch, the numbering system is used with the accidentals to simplify the notation by using as few symbols as possible.

19 Tone Equal Temperament and the Horn:

Scales which divide the octave into an equal number of parts other than 12 can also fall under the category of microtonal music. One of the most common (and oldest) scales uses a division of the octave into 19 equal parts, which is about 63 cents per interval with 1200 cents to the octave. It is with this scale which Guillaume Costeley wrote his microtonal chanson *Seigneur Dieu ta pitié* in 1558.

By taking advantage of the horn's naturally occurring microtonal potential, it is possible to play in 19-Tone equal temperament within a limited part of the horn's range. The diagram below uses a notation system developed by Wesley Woolhouse and Easley Blackwood Jr. which allows all 19 notes in the scale to be uniquely notated by making formerly enharmonic pitches represent different notes. For example, C# and Db represent the same pitch in a standard 12-Tone system, where in the 19-Tone system they represent different pitches with Db slightly higher than C#. The only remaining enharmonic pitches in this system are E#/Fb and B#/Cb. By doing this, the 19-Tone system can be notated without the need for additional symbols.



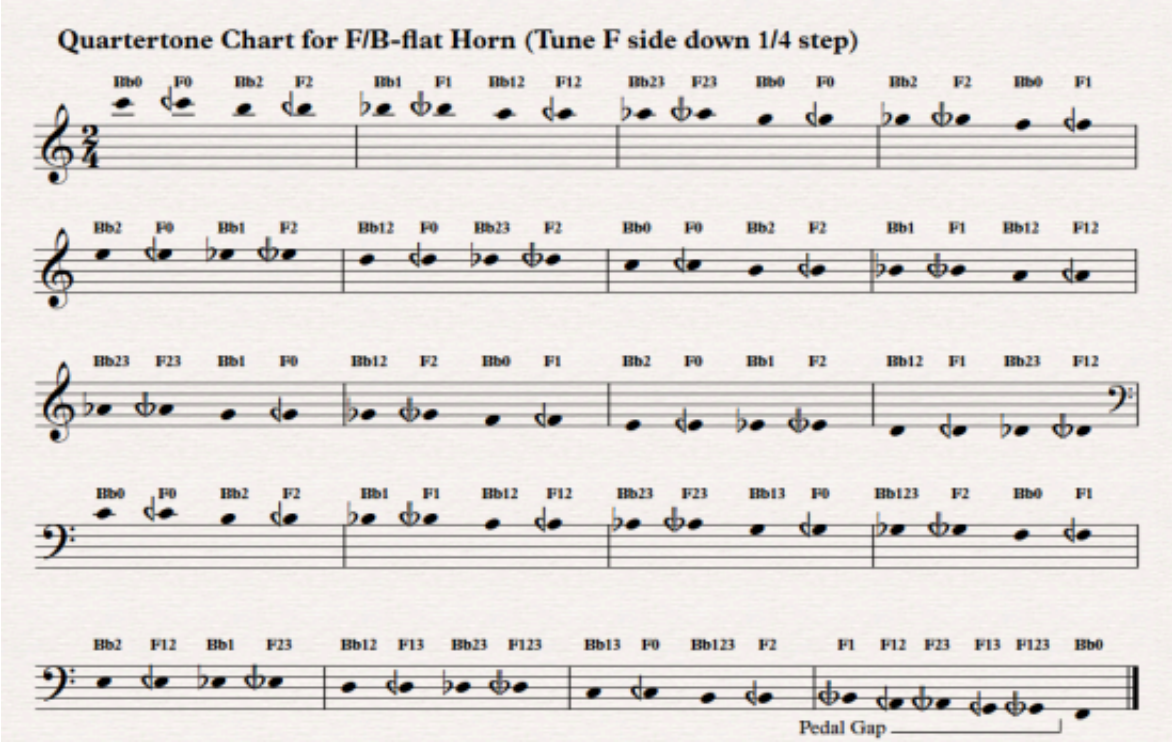
(http://theoilvalleyhornist.files.wordpress.com/2012/11/microtonality-and-the-horn-example-no-5-19-tone-equal-temperament-for-the-horn.png)Although the intonation of this scale is not perfect, most of the pitches are within a 1/20 step (5 cents) of the perfect 19-Tone tuning, which is generally far too subtle to be noticeable. The scale in the diagram above also works when transposed up an octave, in which case the partials listed will be different but all of the other details (the fingerings and cents) will remain the same. An example of a 19-tone system in use can be found in Mathew Rosenblum's composition, *Continental Drift*, a trio for horn, percussion, and 2 keyboards with differing intonation (for 1 player). The horn and keyboards alternate between using the standard 12-tone system and a 19-tone system.

Alternate Tunings in Quartertones and Beyond:

While the notes from the 7th, 11th, and 13th partials of the horn's overtone series can be used to play quartertones, the technique is limited to the top two octaves of the horn's range. Though convincing,

these partials are not tempered which means that these notes are not exact quartertones. A full quartertone is a distance 50 cents, the 7th partial is 31 cents flat, the 11th partial is 49 cents flat, and the 13th partial is 59 cents flat. While the 11th partial is almost an exact quartertone, the 7th and 13th partials are noticeably different (especially the 7th).

The double horn, which contains two complete and separate sets of piping, can be tuned to a tempered quartertone system by taking advantage of this two-key system. By taking the F side (of a standard F/B-flat horn) main tuning slide and tuning it down a full quarter-step, the horn can now play a quartertone 'chromatic' scale throughout the entire range of the range, except for the pedal gaps in the lowest octave.



(http://theoilvalleyhornist.files.wordpress.com/2012/11/microtonality-and-the-horn-example-no-6-quartertone-fingering-chart-alternate-tuning.png)

This technique can also be applied to descant and triple horns, regardless of the keys the horn is constructed in. Use the lowest keyed side for the quartertone tuning because the longer side will more easily tuned down the quarter-step distance. Triple horns, which are becoming increasingly common, present an even greater possibility. By having three sides, a triple horn can be tuned in tempered third tones or some other varied intonation. For example, an F, B-flat, E-flat triple horn would have the F side tuned down two-thirds of a step (67 cents), the B-flat side would be tuned down a third-step (33 cents) and the E-flat side would remain at standard tuning.

Other Effects (Pitch-Bending, Right-Hand Techniques, and Half-Valving):

There are numerous other effects possible on the horn which could be considered microtonal. Bending the pitch with the embouchure, adjusting the pitch with the right hand, and using half-

valved effects to distort the pitch can create microtonal inflections. The difficulty with these techniques is that they are characterized by a lack of control and projection, which makes them difficult to play with precision but are still useful for indistinct effects. Many of these effects are characteristic of jazz, including blue note inflections, and are played using these techniques.

Mechanical Alterations:

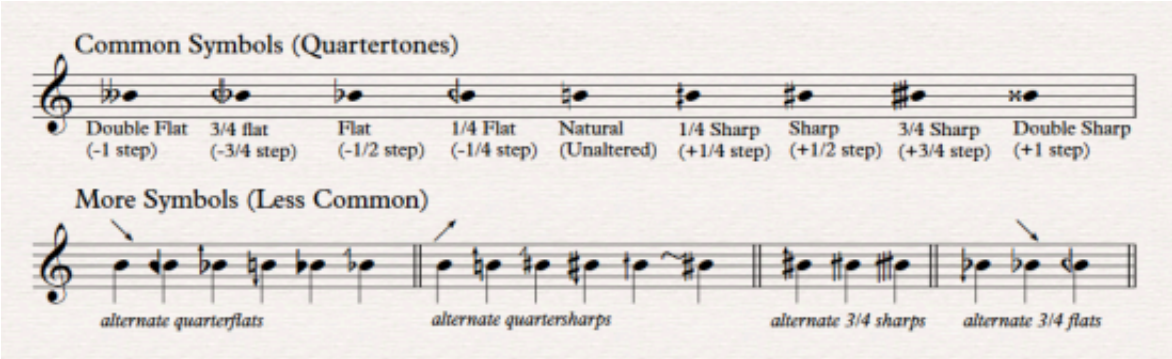
(http://theoilvalleyhornist.files.wordpress.com/2011/10/microtonal-horn-closeup.jpg)Since a 12-tone equal temperament system has dominated the Western music tradition for centuries, nearly every instrument has been designed to play in this system, which means microtonality can be a difficult if not impossible request for certain instruments. However, for some instruments, such as the trombone and the violin, microtonality is a simple request. It is the instruments which have within their design some mechanism which changes the pitch by a specific interval that have the most difficulty with microtonality, such as the trumpet's valves, the piano's keys, and pitched percussion which are physically designed to play specific pitches. For these instruments, microtonality is either extremely limited or entirely impossible.

But for every problem, there is a solution, and many instrument makers have risen to the challenge presented by composers by creating new instruments or modifications which are capable of playing more complex tonalities. The horn pictured here has added quarter and eighth tone rotary valves and the instrument maker Marcinkiewicz sells 4-valve quartertone trumpets and flugelhorns. A few other examples of this kind of innovation include a double-barreled quartertone clarinet, a 19-tone equal temperament fretted guitar, quartertone pianos and marimbas, and electro-acoustic hybrid instruments. The theoretical possibilities of such instruments are limited only by what musicians and composers can imagine and what instrument makers can build.

This video is of Stephen Altoft and Samuel Stoll discussing a microtonal trumpet and a microtonal horn at Goldsmith's College, London in April 2010. The horn has a set of valves which lower the horn a quarter-step and an eighth-step, which allows it to perform an eighth-tone scale throughout its entire range.

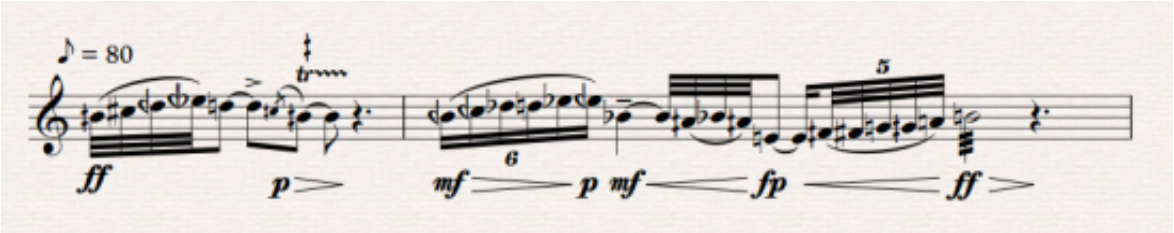
Microtonal Notation:

Understanding microtonal notation can be rather difficult because there is no standard method of writing micro-intervals. Now there are some fairly recognizable symbols used for microtones such as the backwards flat, which is sometimes used to mean quarterflat (-50 cents), but has also been used to mean three-quarterflat (-150 cents). This is the second major problem: that many symbols are used to mean different things by different composers.

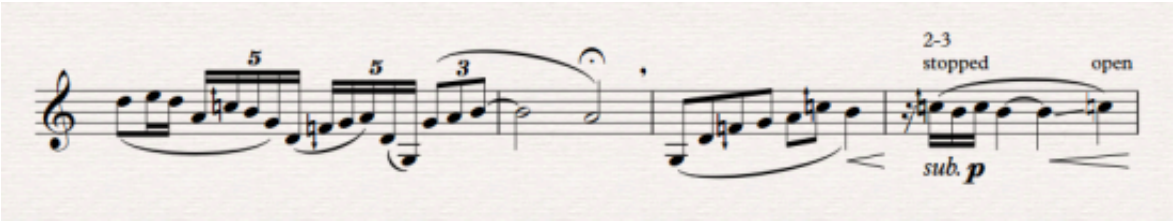


(http://theoilvalleyhornist.files.wordpress.com/2012/11/microtonality-and-the-horn-example-no-7-v2-common-quartertone-symbols.png)Even though microtonality is becoming a fairly common request, it is still unusual enough that most performers will not be familiar with it. Because of this, when composing a microtonal piece for the horn, it is best to explain all of the symbols being used it

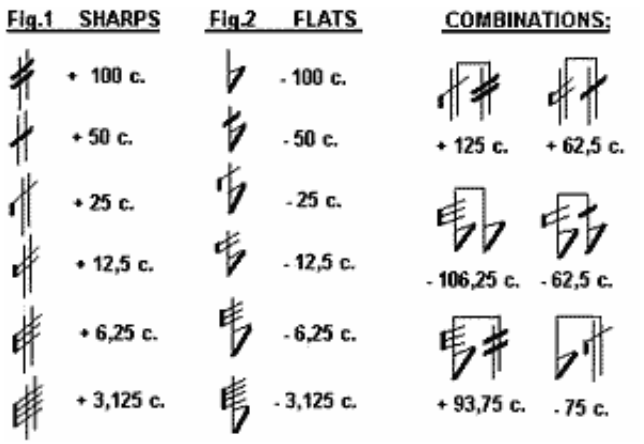
that piece by including a set of performance notes with the composition. Also helpful is to include a set of fingerings for all of the microtonal intervals used in the piece as many of them require rarely used alternate fingerings that most horn players will not automatically know. The best practice is to be as clear as possible to eliminate any doubts and confusion.



(http://theoilvalleyhornist.files.wordpress.com/2012/11/microtonality-and-the-horn-example-no-10-robert-hasegawa-the-clear-architecture-of-the-nerves-mm-1-2.png)Hasegawa, Robert: *The Clear Architecture of the Nerves*: This passage shows the most common method of notating quartertone music. These symbols typically do not require any explanation, but not every musician will recognize them.



(http://theoilvalleyhornist.files.wordpress.com/2012/11/microtonality-and-the-horn-example-no-9-jeff-morris-etude-for-horn-no-3-mm-5-8.png)Morris, Jeff: *Etude for Horn No. 3*: This passage from Morris' etude uses a slightly less common arrow-based notation similar to the notation found in Ligeti's concerto. The arrows attached to the accidentals mean that the pitch is to be moved one quarterstep in the direction of that arrow, in addition to the accidental. Hence, the naturals with an upward arrow are actually a quartersharp. This system is easy enough to understand, but the disadvantage of this system is that the arrow notation can easily be missed or misinterpreted, especially in handwritten manuscripts. Also, this notation can be used to simply mean slightly higher or lower. These accidentals work well for that purpose especially in conjunction with other accidentals meant to refer to specific quartertone intervals.



(http://theoilvalleyhornist.files.wordpress.com/2011/10/kogut-notation.gif)In addition to the myriad of microtone accidentals, there are several complete notational systems designed for microtonal music. The one pictured at the right is known as Kogut notation after the Ukrainian musicologist Gennadiy Kogut. This notation is very useful for music requiring eighth-tones and sixteenth-tones and the like, but is limited by the fact that it is really only suitable for tonal systems that are derived from divisions of the 12-tone system (quartertones (24 per octave), eighth-tones (48 per octave), sixteenth-tones (96 per octave), and so on). Another system is known as the Sagittal (http://www.sagittal.org/) system, an incredibly complex system containing several hundred symbols designed to be able to notate every conceivable microtonal interval.

An incomplete list of compositions for the horn containing microtonality:
Burdick, Richard: Planetary Ripples, Op. 102 (for 16 similar instruments).
Grisey, Gerard: Epilogue from Les Espaces Acoustiques (Orchestra with 4 Solo Horns), Accords Perdus – Cinq Miniatures (2 Horns).
Hasegawa, Robert: The Clear Architecture of the Nerves (for Horn alone with piano resonator).
Ligeti, Györyi: Hamberg Concerto (for Horn & Chamber Orchestra with 4 Obbligato Natural Horns), Trio for Horn, Violin, and Piano.
Mazis, Spiros: Ialemos (for Horn alone).
Morris, Jeff: Etude for Horn.
Patterson, Robert G.: Pastorale (for Horn alone), 4 Pieces for Natural Horn (for Horn alone), Valediction (for 8 horns).
Pehrson, Joseph: Harmonic Etude (for Horn alone), Nature's Harmony (for 2 Horns).
Polansky, Larry: Horn (for Horn and Live Electronics/Horn and Tape).
Rosenblum, Mathew: Continental Drift (Trio for Horn, Percussion, and 2 keyboards).
Shigeru, Kan-no: Hornstück (for Horn alone).
Xenakis, Iannis: Anaktoria (for chamber ensemble).

Links and Sources:
Burkholder, J. Peter, Etc. "A History of Western Music, 7th Edition." W. W. Norton & Company, Inc. 2006.

Hill, Douglas. "*Extended Techniques for the Horn.*" Warner Bros. Publications U.S. Inc. 1996.